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UTILITY PATENT APPLICATION

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INVENTION:

WELL COMPLETION CONVERTIBLE FLOAT SHOE/COLLAR

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WELL COMPLETION CONVERTIBLE FLOAT SHOE/COLLAR

FIELD OF INVENTION

This invention relates generally to apparatus for use in well completions in wells where it is undesirable to put excess pressure on the well bore caused by lowering the casing into the well bore.

BRIEF DESCRIPTION OF THE PRIOR ART

In the process of drilling a well it becomes necessary to stabilize the borehole from collapse of its walls, to set well casing in the well bore and to fix it in place by cementing it in place. The well may then be drilled further, or the completion process to begin hydrocarbon production may be carried out.

In vertical or horizontal boreholes, or sections of a well having vertical and horizontal boreholes, one or more casing strings are lowered into the hole and are anchored therein by a column of cement placed in the annulus between the casing string and the wall of the borehole. It has become conventional practice to fill the casing string with heavy drilling fluid or mud which prevents the increasing subterranean pressure from crushing inwardly, or collapsing, the casing string as it is lowered, or floated, into the well bore. When the string has been placed at the desired depth, being held at the surface or placed on a hanger from a previously set casing string of larger diameter, a wiper plug is launched into the casing string and oil well cement is added to the string above the wiper plug. Pressure pumping apparatus at the surface is used to pump the mud, and then the cement out of the lower end of the string and past a float shoe, or well tool having a back pressure valve, at its lower end and into the casing/well bore annulus. It should be mentioned that if the back pressure

valve or float shoe is located at the bottom end of the casing string it is referred to as a float shoe. If this device is used interiorly to the length of a full casing string, it is referred to as a float collar. The difference in the use of this type of device as a shoe or a collar is merely whether it is threaded to the casing on one end (shoe), or on both ends (collar).

When the wiper plug lands on the float shoe, increased pumping pressure is used to burst or rupture a frangible diaphragm across the interior of the wiper plug and to permit the cement to go into the annulus, which was above the wiper plug. The back pressure valve in the float shoe prevents the cement placed in the annulus from simply re-entering the casing into any cement ports above the valve. In any case, when the desired amount of cement has been pumped into the annulus and has set, a drilling tool is lowered into the casing string and used to drill out the plug (or plugs) and the float shoe containing the back pressure valve. This opens the lower end of the casing string for further completion operations or drilling.

Some float shoes having mud jets, or directed openings, facing downwardly have been used for assisting lowering of casing into place by providing downwardly directed mud jets during the casing run in to assist circulating out any rock "cuttings" present in the uncased section of borehole. The downwardly facing jets assist in moving any remaining rock "cuttings" in the well bore to be circulated out of the well via the annulus between the casing and borehole wall during the run in operation. Some such tools used as float shoes have had upwardly facing fluid ports or jets to assist in the distribution of cement into the borehole/casing annulus once the tool is in place. No known float shoes having both types of fluid ports or jets have been used.

In the use of this type of float shoe, one or more back pressure valves (or one way valves) are positioned by cementing them into a short piece of pipe threaded to the end (when used as a shoe) or to a section between casing lengths (when used as a collar) of the casing string. These check valves prevent the re-entry of cement or mud interiorly to the casing during the run in and cementing operation. A float shoe or collar of this type can have other possible valve configurations. Such valves can be configured to only act as check valves when "activated" such as by running in an activation tool or pumping an activation tool or an obscuration ball down the casing string from the surface.

Downwardly facing ports or jets are useful during casing run in. Upwardly facing jets promote the equal circumferential distribution of cement when cementing takes place. The upwardly facing jets create turbulence in the casing/borehole annulus and this tends to promote desired circumferential distribution of cement about the annulus.

It is apparent from the foregoing that it would be highly desirable in optimizing the run in and cementing operation that a float shoe or float collar having jets directed in a downward direction during the run in, and then having jets directed only in an upward direction during the cementing operation, would make such an operation much safer, more economical, and more efficient. The float shoe/collar apparatus of the present invention provides just such a reliable, safe and economical system.

BRIEF DESCRIPTION OF THE INVENTION

The apparatus of the present invention comprises a float shoe (or which could be used as a collar) that incorporates a check valve, or a plurality of such valves, which can allow the casing to fill

up from the bottom with well fluid (auto fill) during run in. Below the valve, or valves, is a center outlet hole as well as both upwardly and downwardly facing jets. A tube inside the float shoe holds the flapper (or check) valve(s) mechanism open to allow fluid into the casing. This same tube also covers and closes a set of upwardly facing jets during run in. The downwardly facing jets are open to aid in washing the borehole wall during the casing run in or float in. Once the casing string has reached the desired depth, an obscuration ball or a tool is pumped down the casing. The ball seats in the float shoe tube. With an increase in pumping pressure from the surface, the seated ball then causes the float shoe tube to move downwardly inside the tool. The downward movement allows the check valve(s) (or flappers) to swing closed, thus activating the check valve(s). When the tube shifts downwardly it closes and shuts off the downwardly facing jets and exposes, or opens, the upwardly facing jets to assist in cement distribution, during the cementing operation, to all sides of the casing.

The invention may be best understood by reference to the detailed description thereof which follows and by reference to the appended drawings. The drawings are intended to be illustrative of the preferred embodiment of the invention but are not intended to be limitative of the invention as it may admit to more than one embodiment.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic side view in section of the apparatus of one embodiment of the invention (shoe form) in place in a short section of pipe threaded on its upper end to fit the casing string.

FIG. 2 is a schematic side view in sections of a portion of the apparatus of FIG. 1 with the internal tube in its upward position.

FIG. 3 is a schematic side view in section of the apparatus of FIG. 1 and 2 with the internal tube in its downward position and with the check valves closed or activated.

FIG. 4 is a schematic side view in section of the apparatus of FIG.'s1, 2 and 3 with the check valves.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

Referring initially to FIG. 1, a well tool according to the invention is shown in a side view in section. The tool 14 is included and cemented n a short piece of pipe 21 threaded to fit the casing 11 sections on the casing lower end. FIG. 1 detail of the installation of the tool 14 is shown in the short pipe section 21 which is threaded to fit onto a well casing on the tools' upper end 14A. Short pipe section 21 is provided with interior teeth or threads 26 and outer cylindrical body member 25 is held in place by cured cement or other attachment means 21A prior to its attachment to the casing string being run in and cemented in place. A movable inner tubular member 27 is held in place with respect to outer member 25 by one or more shear pins 28. The shear pins 28 are designed to shear when a desired lateral force is applied to them (as will be described) and to then permit downward longitudinal movement of inner member 27 with respect to outer member 25. When the cementing operation is complete, the entire float shoe assembly 14 is constructed of such readily frangible material as to make it readily drillable by a tool lowered through the set casing.

In FIG. 1 an activation ball 23 is shown seated on a catcher/seat 23A. In the run in operation, of course, ball 23 could be kept on the surface until it is desired to activate the apparatus of FIG. 1. The bore 29 of inner member 27 may be fully open during the run in for auto fill. The outer member 25 is provided at its lower end with a plurality of downwardly facing jet openings 30 which are open

in the position shown during the run in operation. The bottom opening 14B of tool 14 may also be open during run in to allow fluid entry/exit through it and jets 30 into the borehole. Fluid pumped under pressure from the surface exits all the openings and, if desired, circulation may be maintained to "wash" rock cuttings left in the hole upwardly in the annulus 12 during this operation, assisted by the operation of downwardly facing fluid jets 30.

The outer member 25 is provided with a plurality of check valves 31, shown as flapper valves 31, which are held in their open or unactivated position in the interior annulus 32 between inner member 27 and the outer member 25 in the run position. The outer member 25 and the pipe section 21 are also provided with upwardly facing jet openings 33 and 33A which are initially blocked in the run in position as shown in FIG. 1.

Referring now to FIG.'s 2, 3 and 4, the portion of the float shoe of FIG. 1 held in the cement sheath 21A is shown in three different positions. FIG. 2 shows the apparatus in the auto fill up mode (or run in mode) with bore 29 fully open to fluid flow and fluid jets 30 and bottom opening 14B also fully open. FIG. 4 shows activation ball 23 caught on a catcher portion 35 of inner member 27 at its lower end and with the member 27 released to move, having sheared off the shear pins 28 of FIG. 1 forming a movable integral piston which has moved downwardly until caught on a shoulder 38 of outer member 25 at its lower end. The piston formed by movable inner member 27 has blocked off downwardly facing jets 30 and also the lower opening 14B of the shoe 14. In FIG. 3 the valves 31 are still open, being held there after passage of piston assembly member 27 by fluid pressure from above. This motion of member 27 has also uncovered the upwardly facing jets 33A of member 25

allowing cement to be exited and distributed to the annulus between the casing and borehole wall, equally about all exterior sides of casing string 11.

A brief release of the pumping pressure from the surface allows valves 31 to close and seat, thus preventing the cement from "u tubing" or "flowing" back into the casing between pump strokes. Valves 31, when activated, thus act as check valves for this purpose. This arrangement of the apparatus of the invention provides an optimal jetting action during run in, which is switched over or converted into an optimal jetting action for cement distribution, automatically upon activation of the downhole check valves. The system is safe and economical and very reliable.

The invention may admit to other embodiments than that shown when disclosed to those skilled in the art. It is the aim of the appended claims to cover all such modifications and variations that fall within the true spirt and scope of the invention.